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The Stable Fly

How to Prevent Its Annoyance and Its Losses to Live Stock

THE ACUTE PAIN produced by the insertion of the proboscis of the stable fly brings to any man a sudden realization that this biting insect is pointedly different from the house fly or typhoid fly, although hitherto his opinion had been that the two were identical.

At times this fly becomes excessively abundant and occasions heavy losses among nearly all classes of live stock. Year in and year out it is a source of great annoyance, especially to horses and cattle, and is an all-too-common and persistent pest.

The adult stable fly resembles the house fly, but is slightly broader and feeds principally on the blood of animals, which it draws with its long, piercing mouth parts. It breeds in accumulations of various kinds of vegetable matter and also in manure, especially when the latter is mixed with straw. When straw stacks become wet soon after thrashing the flies breed in the decaying straw, and it is this set of conditions which produces the severe outbreaks.

Spraying animals with repellents is not very satisfactory, but the numbers of stable flies can be kept down by caring properly for stable refuse and by stacking or otherwise disposing of straw as described in subsequent pages of this bulletin.

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L. O. HOWARD, Chief
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THE STABLE FLY: HOW TO PREVENT ITS ANNOYANCE AND ITS LOSSES TO LIVE STOCK.

By F. C. Bishopp,

Entomologist, Investigations of Insects Affecting Health of Animals.

CONTENTS.

	Page.
A tormenting and injurious pest	3
The common names of the insect and how it may be recognized	4
Distribution and abundance	4
Character of injury and losses	5
Summary of life history	7
Development and habits	8
Breeding places	8
Habits of the adult	9
Reproduction	11
Length of life of the adult	12
The larva and its habits	12
Life cycle	12
Hibernation	13
Agricultural practices in relation to fly abundance	13
Natural control	14
Climatic effect	14
Predatory enemies	16
Parasites	16
Artificial control	16
Protection of live stock from attack of the stable fly	16
Trapping the flies	18
Destruction of immature stages and prevention of breeding	19

A TORMENTING AND INJURIOUS PEST.

THE stable fly,[1] or stock fly, is one of the most important sources of annoyance to live stock throughout the United States. When present in small numbers it has no apparent injurious effect, but on frequent occasions conditions arise which permit its development in enormous numbers, and at such times the injury to all classes of live stock becomes marked.

In addition to being a source of annoyance to domestic animals, the stable fly, when present in large numbers, has a deleterious effect upon them owing to the quantity of blood drawn, and animals not infrequently are so reduced in vitality as to permit certain diseases to become acute and cause their death. In Africa and other parts of the world this fly is capable of transmitting certain serious maladies of horses and camels. In our country it probably plays a part in the dissemination of anthrax, and recent investigations indicate that the disease of horses known as swamp fever or infectious anemia is carried by it. Work thus far conducted indicates that the fly acts solely as a mechanical carrier, passing these diseases directly from one animal to another in biting.

[1] Known scientifically as *Stomoxys calcitrans* L.

In addition to its rôle as a live-stock pest, the stable fly is important as an annoyer of man and there is some indication that it is concerned, in part at least, with the transmission of certain diseases of man, most notable of which is infantile paralysis.

THE COMMON NAMES OF THE INSECT AND HOW IT MAY BE RECOGNIZED.

"Stable fly" is not entirely satisfactory as a common name for this pest, as it is frequently abundant in open fields and along roadways and is not uncommonly encountered about the house. Nevertheless it is found about stables more frequently than anywhere else. In certain localities such names as the "stable fly," "wild fly," "straw fly," and "biting house fly" are applied to it.

As the last name suggests, this insect is frequently confused with the house fly[1]. The common house fly is not capable of biting, its mouth parts being soft and broad on the tip. On the other hand, the stable fly has mouth parts well fitted for piercing the skin of animals and sucking blood. The presence of such biting mouth parts, therefore, distinguishes it at once from the house fly. The tip of the beak can be seen protruding from beneath the front of the head when the fly is at rest (see figs. 4 and 5). The insect is usually slightly larger than the house fly and more robust. It usually alights upon an animal with the head directly upward, while another insect sometimes confused with it, the horn fly,[2] rests with its head downward, and the house fly may assume various positions and moves much more frequently. The horn fly is much smaller than the stable fly, the wings are widely spread at the tips, and it is usually present on cattle only, where it occurs in small swarms, moving from one part of the animal to another when disturbed.

DISTRIBUTION AND ABUNDANCE.

The stable fly is very widely distributed throughout the world. In fact it seems to have followed man and his domestic animals to all quarters of the globe. It becomes more abundant, however, in the temperate regions, such as the United States and Argentina. In the United States it is to be found everywhere, but within the confines of this country its abundance varies considerably.

Serious annoyance to live stock is most common in the Central States from Texas to Canada, where grain is grown extensively. Reports indicate that it may be important occasionally in various other sections and is a more or less persistent pest in all irrigated regions.

From time to time exceedingly severe outbreaks of this insect occur. One of the worst in recent years took place in 1912. Injury in north-

[1] Known scientifically as *Musca domestica* L.

[2] Known scientifically as *Haematobia irritans* L.

ern Texas and in Oklahoma during the late summer and early fall of that year was unprecedented. The pest was abnormally numerous throughout the entire grain belt, including the southern portions of central Canada. Since 1912 the insect has appeared in great numbers on two or three occasions, but these outbreaks have been more or less local.

This fly appears not infrequently on warm days during winter and early spring in the Southern States, but seldom does it become sufficiently abundant in any part of this country to cause annoyance before early summer. It nearly always increases in abundance and injury is most acute during August and September.

CHARACTER OF INJURY AND LOSSES.

Practically all warm-blooded animals are attacked by the stable fly, but some domestic species are much freer from injury than others. This is due largely to protection afforded by the hair of the host or by some of its habits. Mules, horses, cattle, hogs, dogs, cats, sheep, and goats are subject to attack in about the order named. The worriment caused to individual animals varies greatly with their temperament.

As has been indicated, this fly is of importance in a number of ways. There is little doubt that it is a potent factor in disease transmission, although actual proof of this has been secured in the case of a few diseases only.

Aside from conveying disease, this insect is of much importance on account of the worry produced by its bites. During severe outbreaks this is probably the most important cause of losses. In periods of great abundance all live stock are compelled to keep up a constant fight against flies from early morning until dark. At such times the flies are present not only around barns but in towns, cities, and open fields. Animals which are being worked in fields or on the streets and those kept in stables suffer alike. During the severe outbreak of 1912 many horses and cattle became so weak that they gave up the fight against the pest and the flies swarmed over them in countless numbers. In a few cases, where the animals were not promptly protected from attack, they succumbed in a short time.

The loss of blood during severe outbreaks is an important consideration. When fully engorged the abdomen of the fly is greatly distended, and it has been found that the blood extracted at one feeding is soon digested and the fly is ready for another meal. Thus animals continually exposed must serve to engorge thousands of individuals each day, each of the flies ingesting several drops of blood during a meal.

In the portion of the United States where Texas fever occurs, in addition to the live stock actually killed by worriment and loss of blood, a considerable number of cattle are lost from Texas fever. In most of these animals, although the disease organisms are latent in the blood, no apparent injury would result under conditions favorable to live stock. Under the strain of continually fighting the flies and with the weakened condition brought about by the loss of blood, however, an acute form of Texas fever is induced. When animals begin to suffer from the fever they are less energetic in fighting the flies and consequently become the more ready victims. During the outbreak in 1912 acute Texas fever was certainly produced as a result of fly attack. Owing to the continual biting of the insect the fever could not be reduced in many cases and the animals speedily died.

During severe outbreaks the milk supply in fly-infested zones is much reduced. In the 1912 outbreak many dairymen found that their output of milk was reduced from 40 to 60 per cent, and that in some cases cows were completely dried. For several months after the pest had abated, the effects of the outbreak were apparent in the reduced milk production. Even in cows which freshened several months after the pest had abated, the effect on milk yield was said to be apparent.

During 1912 all animals in the fly zone were greatly reduced in flesh. In many cases cattle which had been fat enough for market were so much reduced that they could not be sold. Horses and mules in many cases lost from 10 to 15 per cent in weight during the outbreak. Some dairy herds which were usually shown at the State fairs suffered such marked injury that they were not fit for exhibit.

In many cases the joints of both horses and cattle became so swollen and stiff, from standing in water where they sought protection from flies, that they could scarcely walk. The incessant stamping of the animals also had the effect of injuring the feet and joints. A number of liverymen found it necessary to discontinue making drives into the country, and some of their animals were completely disabled for regular work.

Another source of loss to farmers was their inability to proceed with their usual farm plowing and other operations at the proper time. In many sections the flies were so bad on the horses that they could not stand both the work and flies. Some men resorted to night work as a means of escaping the attack, but this was too severe for the teams, as the flies allowed them no rest during the day. Numerous instances of horses becoming frantic from irritation were recorded; these often resulted in runaways and consequent destruction. Animals which were not being worked sometimes received injuries from running into barbed wire fences in endeavoring to escape the flies.

The total loss due to the outbreak in 1912 is difficult to estimate. It is believed that in northern Texas over 300 head of cattle, mules, and horses were killed directly or indirectly as the result of the fly attack. The actual death loss may be conservatively placed at $15,000. The loss due to the reduction in milk supply may be reasonably placed at $10,000, and other losses far surpass these two items. Moreover, these were the losses experienced only in the few counties in northern Texas where the fly was most abundant and do not include the more or less serious injury sustained in practically the entire grain belt.

FIG. 1.—Eggs of the stable fly attached to a straw. Greatly enlarged.

SUMMARY OF LIFE HISTORY.

Like all other flies, this species has four stages in its life history, namely, the egg, larva, pupa, and adult.

The egg.—The eggs of this fly are elongate ovoid and of a creamy white color. They are about one twenty-fifth of an inch in length and under a magnifying glass show a distinct furrow along one side. When placed on any moist substance they hatch in from 1 to 3 days after being deposited. In hatching a small slit is made around one end of the groove, and the minute maggot crawls out. Figure 1 shows four eggs on a piece of straw; the two at the right have hatched.

FIG. 2.—The stable fly: Larva, or maggot. Greatly enlarged.

The larva, or maggot.—When first hatched the larvæ, or maggots, are about one-twelfth of an inch in length and, being translucent, are not easily seen with the naked eye. Development takes place fairly rapidly when the proper food conditions are available, and the growth is completed within 11 to 30 or more days. When full grown the larvæ (fig. 2) are pale yellow or nearly white and about four-fifths of an inch in length. They have the typical shape and action of most maggots of this group of flies. The hind end is large and the body tapers to the head. The larva moves rapidly by means of minute projections on the edge of each segment along its under side. When exposed to the light it quickly disappears in the straw or other matter in which it is breeding.

The pupa.—When the larvæ are full grown they shorten and become thicker, and the skin contracts and hardens to form the case in which the transformation to the adult is to take place. This

puparium, or pupal case (fig. 3), is rather soft and yellowish at first but soon becomes harder and changes to reddish brown. It is elongate oval, slightly thicker toward the head end, and from one-sixth to one-fourth of an inch in length. During this stage the insect is completely dormant, the transformation from maggot to adult fly going on within the puparium. This resting stage requires from 6 to 20 days, or in cool weather considerably longer.

FIG. 3.—The stable fly: Pupa. Greatly enlarged.

The adult.—When the fly has completed its development within the puparium it pushes its head against the end until the shell splits open. Then it crawls out as an adult fly, but so different from the fly ordinarily seen that one would scarcely recognize it. the color is pale and the head bulges out in front between the eyes. At this time the wings are only small wrinkled sacs. In a few minutes air is forced into the wings, and they unfold slowly, the fly becomes gradually darker in color, and its body becomes harder. Up to this time the beak is not visible, as it is bent downward between the legs. Soon it becomes almost black and is brought forward in its natural position so that the tip may be seen from above. When completely dried out the adults show four rather distinct, dark, longitudinal markings on the thorax, as well as several dark spots on the abdomen. The male usually is slightly smaller than the female, the body of which measures from one-fourth to five-sixteenths of an inch in length. The adult, as seen from above, is shown in figure 4, and a side view of a female specimen engorged with blood is shown in figure 5.

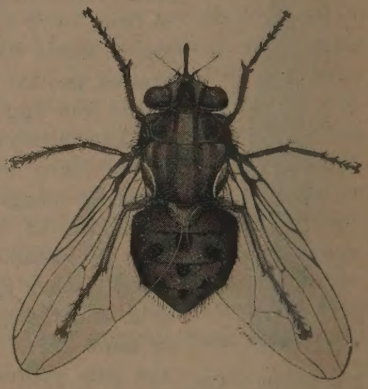

FIG. 4.—The stable fly: Adult as seen from above. Greatly enlarged.

DEVELOPMENT AND HABITS.

BREEDING PLACES.

Horse manure has been considered the normal breeding medium for this pest. Investigations made during the outbreak in 1912 showed clearly, however, that the vast majority of the flies bred out in straw stacks, and investigations made around stables and barns indicate that while the fly breeds in pure horse manure it favors a

mixture of this substance with straw. The fly was found to be breeding in much greater abundance in oat straw than in wheat straw. This appeared to be due to the softer stems and the greater amount of leaves in the oat straw, which furnished better food and allowed the stacks to become more compact. Rice straw was found to furnish suitable breeding conditions, and there is little doubt that barley and rye often serve as food for the immature stages.

It has been found by Prof. Iches to breed in Argentina in great numbers in the débris left after thrashing flax. A careful examination of portions of alfalfa stacks which were moist and readily accessible to numbers of flies showed that they were not infested, nor were accumulations of weeds and bunches of grass in open fields. The insect occasionally may breed in broken-up masses of hay or dead grass, especially when these are permeated with liquids from manure, and corn husks in feeding pens have been found to harbor the maggots.

The manure piles commonly found near stables where horses are kept furnish suitable breeding conditions. This is especially true in the early spring, when the warmth of the manure appears to be very attractive to the flies for egg laying. Cow-lot manure which has become broken up, especially when mixed with waste feed, is utilized as a breeding place; and so is ensilage, particularly when mixed with straw, as is often the case when the bottom of a silo is cleaned out. Experimentally, a few specimens have been reared from pure cow manure, but this substance seems to be unattractive to the adult and not favorable for the breeding of the larvæ on account of its very compact texture.

FIG. 5.—The stable fly: Adult female, side view, engorged with blood. Greatly enlarged.

The stable fly has never been found breeding in human excrement and does not frequent malodorous places, which are so attractive to the house fly; hence it is much less likely to carry typhoid and other germs which may be found in such places.

This insect develops somewhat more slowly than the house fly, and it is therefore more essential, in order that it may breed successfully, that the eggs be deposited in rather large accumulations of material. The larvæ are sensitive to drought and soon succumb if the material in which they are developing is not kept rather moist.

HABITS OF THE ADULT.

Both the male and female of this species feed on the blood of animals. They appear to discover their host mainly by sight and usu-

ally, especially on cattle, pass quickly to the lower portion of the legs, particularly on the outside, where the hair is somewhat shorter than on other parts of the animal and where they are less likely to be struck by the tail of the host. When the flies are very abundant their attack is by no means confined to the legs, as both cattle and horses have been seen practically covered with flies on all parts of the body. They seldom remain on the host long without inserting the beak. Before blood is extracted they are easily disturbed and often move about several times before settling down for final engorgement. After the beak is well inserted and the blood begins to flow they usually become engorged in from two to five minutes. The insertion of the beak is accompanied by a rather severe, sharp pain. This accounts for much of the worriment caused to the host. After blood extraction has begun little or no pain is felt. During feeding the abdomen becomes greatly distended (see fig. 5) and often of a distinctly reddish color. When satisfied the fly withdraws its beak and flies rather sluggishly to some near-by object, where it rests while digesting its meal. When the proboscis is withdrawn a drop of blood usually exudes from the wound. Numerous small flies have been seen to frequent the blood which exudes in this way, and it is not improbable that the screw-worm fly [1] may deposit its eggs on these spots and thus cause infestation of the host with these maggots.

During warm weather the blood is digested rapidly and the flies may feed again the same day. When the weather is cooler they usually require about a day for the digestion of the blood. After partaking of a meal the flies, during hot weather, ordinarily alight on the walls of buildings or on foliage of plants in shady situations. When the temperature is lower they remain in the sunlight, but in all cases they tend to avoid strong wind.

Adults frequently follow for considerable distances teams traversing roads and finally, when engorged, settle on near-by objects. Other teams which pass along the same highways are thus frequently attacked by flies which have completed the digestion of their previous meal, and this has given rise to the idea that the flies are breeding in weeds, grass, and hedges along the highways. This is also a means by which the flies invade territory beyond that in which they develop. Adults have been observed to travel many miles in the passenger coaches of railways. Few individuals are carried in this way, but doubtless the spread of the species is aided and, what is more important, diseases might be spread in this way by infected flies.

Feeding may take place a number of times. Experimentally individual flies have been induced to engorge as many as 14 times. Flies

[1] Known scientifically as *Chrysomyia macellaria* Fab.

have been observed to partake of water and to feed to some extent on succulent fruit. They feed commonly on the moisture on fresh manure and on rotting straw. Although man is bitten by these flies occasionally, horses and cattle seem to be preferred as hosts.

REPRODUCTION.

Mating of the flies takes place while they are not on hosts, and egg laying soon follows, provided the flies have fed a sufficient number of times. It seems that at least three feedings on blood are necessary for the production of eggs. After the third meal is digested the flies seek suitable places for oviposition. When the weather is cool additional feedings are often necessary before eggs are produced. The adults appear to have a keen sense of smell and are able to detect moist straw and suitable manure very quickly. This is especially noticeable when a straw stack which is dry on the outside is opened up so as to expose the moist and rotting interior.

Very soon after a stack is opened flies are seen to come to the moist straw in numbers and begin depositing eggs. Usually they crawl into the loose straw, sometimes going to a depth of several inches. When laying eggs the fly greatly extends the ovipositor and uses it as an organ of touch in locating a suitable spot. The eggs are laid in irregular masses, although occasionally single ones are deposited. The female usually moves several times during oviposition so that each mass contains from a few to as many as 25 or more eggs. The greatest number of eggs which has been observed to be deposited before another meal of blood is taken is 122. After all of the eggs have been deposited the female again seeks a host, and this feeding is again followed by egg laying. Three or more of such ovipositions commonly take place in this species. It is sometimes necessary, especially during cool weather, for a fly to become engorged twice before each oviposition following the first. The greatest number of eggs which has been seen to be deposited by a single female during her life is 632.

LENGTH OF LIFE OF THE ADULT.

A knowledge of the length of life of the adult is important in determining its possibilities as a disease carrier and annoyer of animals. Individuals kept in small tubes without food or water during hot weather died within 2 days. When water and sugar sirup were supplied to flies, in a screen cage about 1 foot square, one specimen out of a large number of males and females lived for 23 days. Individuals which had access to blood at frequent intervals lived 17 days, and a few specimens, among a considerable number which were kept in large cages with cattle and suitable material in which to deposit eggs, lived for 29 days. Under more abnormal conditions other investigators have kept individuals alive more than three months.

THE LARVA AND ITS HABITS.

The larvæ, or maggots, begin feeding as soon as they hatch from the eggs and continue to do so throughout their growth. Portions of moist straw or other material in which they are breeding are torn off by their mandibles, which are located on the narrow or head end of the maggot. When very small they frequently penetrate between the layers of the stalk or leaves of grain when moistened in the straw stack. When larger they often feed within the straws, and transformation to the resting state sometimes takes place in this protected situation.

The larval period lasts from 11 to 30 days, and during very cold weather probably considerably more than a month. The character and abundance of food and the amount of moisture have an important influence on development, and larvæ follow the moisture inward as the material in which they are breeding becomes dry on the surface. Pupation occurs anywhere in the breeding material; it frequently happens, however, that the larvæ, when in small masses of straw or manure, work downward as the material dries and pupate at the surface of the soil.

LIFE CYCLE.

Complete development from the deposition of the egg to the emergence of the adult fly may take place in 19 days, or even in 14 days, according to some investigators. The developmental period, however, usually ranges from 21 to 25 days, where conditions are favorable. Forty-three days is the longest period observed, although it is certain that in the late fall and during the winter months a much longer period is often necessary. The finding of full-grown larvæ and pupæ in straw during the latter part of March, 1913, in northern Texas, shows that development may require about 3 months, as these stages almost certainly developed from eggs deposited the previous December.

HIBERNATION.

In the southern part of the United States there is no true hibernation of this insect. Adults have been found to emerge from their breeding material at various times during the winter when temperatures were not low. It is doubtful if adults appearing under these conditions ever lay eggs. The individuals which pass the winter successfully hatch from eggs laid in the fall and continue development slowly during the winter, emerging in early spring when the temperatures are favorable for reproduction. In the northern part of the United States few flies emerge during the winter months, this period being passed normally in the larval and pupal stages.

AGRICULTURAL PRACTICES IN RELATION TO FLY ABUNDANCE.

Certain agricultural practices favor greatly the development of the stable fly. As has been stated, this species breeds most commonly in straw and horse manure or in a mixture of these two substances. The custom of allowing the manure from the horse stable to accumulate just outside of the stable doors insures the presence of stable flies at all times when climatic conditions are suitable for breeding. Allowing barnyards, especially around dairies, to become knee-deep in manure is also calculated to produce flies in abundance.

In the grain belt it is the practice of farmers to thrash the grain in the fields by means of self-stacking thrashing machines. The individual stacks cover much ground and the straw is very loosely piled. In many cases for convenience several stacks are formed in various parts of a field. When thrashing is followed by heavy summer and fall rains this loosely piled straw is certain to form a breeding place for great numbers of flies. This is precisely what occurred in 1905, 1912, and subsequent years when there were serious outbreaks of the stable fly in Texas. In many instances straw stacks are not protected from live stock. The animals soon scatter the straw and by adding manure still further favor fly breeding. These straw stacks usually are allowed to remain throughout the fall and winter without attention. When the succeeding crop is planted the area occupied by the stacks is simply left uncultivated. Occasionally straw stacks occupy as much as an acre of ground. In a few cases stacks are burned in the spring, but frequently they are left from year to year and the new straw added to the old stacks, destruction only taking place when the stacks become exceedingly large.

It will be seen that these practices not only encourage the breeding of the stable fly, but when the straw becomes sufficiently rotten and compact the house fly as well breeds in it in abundance. Throughout the grain belt a very considerable amount of valuable land is thus left untilled and the full manurial value of the straw is lost. That the stacks serve some purpose as shelter and feed for live stock kept in the fields during winter is the only legitimate reason for not scattering them or burning them in the late summer or fall.

NATURAL CONTROL.

CLIMATIC EFFECT.

The flies feed when the temperature is very high and the sun bright and hot as well as during cool and cloudy weather. They have been observed to attack animals during drizzling rain, and when somewhat protected by sheds and stables they often feed during heavy rain. The lowest temperature at which flies have been observed

to partake of blood was 55° F. When the temperature goes below 60° F. their desire to feed is less marked. Between 40° and 48° F. they lose their ability to fly, and complete inactivity occurs when the temperature ranges between 31° and 45° F. This range of activity is due to variation in individual flies, to the rapidity of the decline or rise in temperature, and to the minimum temperature experienced by the individuals. No flies appear to be killed by a temperature not lower than 27° F., and some at least are able to survive temperatures considerably below this point. All flies at Dallas, Tex., seem to have been killed when the temperature reached 8° F. As has been stated, the flies always seek shady places during hot weather, but when the temperatures are lower they delight to dart about in the sun in a manner very similar to that of the house fly.

The maggots, or larvæ, are very susceptible to drying. This is particularly true soon after they have hatched. Excessive hatched. Excessive moisture, also, is detrimental to their development, and flooding kills them in a few hours. They appear to be able to endure rather high temperatures when abundant moisture is at hand, although the heat produced in manure and straw stacks is often sufficient either to kill them or to drive them outward. No doubt the generation of heat within the breeding places stimulates the development of the immature stages during the fall and winter months. Light is detrmental to the development of the larvæ. When placed in bright daylight, even though sheltered from the sun, larvæ have never been known to complete development. These facts make it possible to destroy the pest in this stage of its life.

The pupæ of the insect, being inactive and protected, are much less susceptible to all climatic extremes. They appear to be able to withstand low temperatures and are not very susceptible to heat or drying, especially after development of the fly has proceeded for some time.

PREDATORY ENEMIES.

Hogs, as well as chickens and other poultry, are capable of destroying great numbers of the immature stages of the stable fly. They are attracted to the straw stacks and manure piles partly by the grain, and incidentally they destroy the maggots and pupæ which they find. Several kinds of insects are important destroyers of these stages. Certain beetles devour them in considerable numbers. The adult flies fall prey to numerous enemies. Among the more important enemies of the adults are the large robber flies, which may be seen in great numbers around straw stacks, pouncing upon stable flies which are depositing eggs or resting upon straw. Wasps of several kinds capture the flies that are attacking stock or flying about. When filled with blood the flies are comparatively sluggish and much more easily caught by these enemies, and spiders often devour them.

PARASITES.

Two species of small wasplike insects have been found to breed within the pupæ of the stable fly. These insects deposit their eggs through the hard puparium, and instead of an adult stable fly the little parasite emerges. In some cases, where the immature stages of the fly were concentrated in great numbers, as many as 40 per cent of the pupæ were found to have been destroyed by these parasites. At least one of the parasites[1] has a wide distribution in this country.

ARTIFICIAL CONTROL.

As is the case with most insects, the destruction of the stage which is actually doing the injury is most desired by those concerned. With this species, as with many others, this is very difficult, and some more easy way of securing the desired end must be determined. With the stable fly the natural point of attack is found in the immature stages, and there is every reason to believe that by properly caring for substances in which it breeds the insect may be kept well under control.

PROTECTION OF LIVE STOCK FROM ATTACK OF THE STABLE FLY.

When adult flies are present in great numbers it is necessary to devise some means of protection against them, especially since we know that every individual is capable of feeding a number of times before it dies. During the recent outbreak in Texas many different substances were tried. Most of the materials used with a view to repelling the flies from live stock have been found to be ineffective, and although some gave a measure of protection for a time, none had a lasting effect. In addition to the temporary value of these substances, in many cases injury was produced by their application, especially if persisted in often enough to keep the flies away. These facts emphasize the importance of taking steps to prevent fly breeding rather than depending on protection of the stock against the flies.

Many malodorous mixtures, particularly of an oily nature, have some value as repellents, but in preparing these care should be taken that they are not made too strong, particularly when animals are being worked in the hot sun, as they are likely to cause overheating and often produce shedding of the hair. A mixture of fish oil (1 gallon), oil of pine tar (2 ounces), oil of pennyroyal (2 ounces), and kerosene (½ pint) was found to be fairly effective in keeping the flies off of live stock for a short time when applied lightly, but thoroughly, to the portions of animals not covered with blankets or nets.

Work animals may be largely protected from the pest by means of coverings. One type of covering which has been found very effective and inexpensive consists of a blanket made of double thickness of burlap so arranged as completely to cover the back, sides, and neck of the

[1] *Spalangia muscidarium* Richardson.

animal (fig. 6). The legs also are then sometimes covered by means of old trousers slipped on over the feet and tied over the back. Leather nets or strips of leather attached to the bridle also aid in keeping the flies from the head. The ordinary fly net has been found to be of little value as it only tends to displace the flies temporarily and cause them to settle in places not covered by the net.

Completely darkened stables offer much protection from the flies, although the resulting lack of ventilation is objectionable. The thorough screening of all windows and doors is much more desirable. When screened barns are used care should be taken to brush the flies from the animals, when they are about to enter, by means of nets over the doorway, or with sacks. Little can be done to protect

FIG. 6.—Burlap covering used to protect horses from the stable fly.

range stock from the flies. On hog farms a freshly plowed trench offers considerable protection to the swine. The sides of these trenches may be smeared with petroleum which is rubbed off on the animals and acts as a repellent. The trench may be used also for protecting sheep, but the petroleum in their case is unnecessary.

TRAPPING THE FLIES.

It is impossible successfully to capture adult flies by means of the traps ordinarily used for the house fly. A trap has been designed by Prof. C. F. Hodge, however, which may be utilized in capturing adults as they enter or leave barns. This trap is undoubtedly very effective under certain conditions and has the advantage of catching not only the stable fly but the house fly and other obnoxious species.

In order to employ the trap for the stable fly it should be built in a frame so as to fit closely in a window, preferably on the brightest side of the barn and close to the cows or horses kept within. Other windows should be darkened by hanging gunny sacks over them. This may be done so as not to interfere with ventilation, and by flapping in the wind and darkening, both drive and cause flies to be attracted to the light-trap window.

Prof. Hodge has very kindly permitted the use of some of his illustrations of this trap (figs. 7, 8, 9), and his description of its construction has been followed. At the bottom of the trap a space about one-fourth of an inch wide running entirely across the window is left on both sides of the frame. This crack admits the flies beneath a roof or ridge of screen wire having holes large enough for flies to go through punched along its top at 2-inch intervals. To capture the house fly, bait consisting of any material attractive to them is placed in pans beneath this ridge. The flies enter this space, ascend through the holes, and are unable to escape. The sides of the trap, also, are made of ordinary screen wire bent inward and upward in two horizontal folds running across the window, one toward the bottom and one toward the top. The ends of the screen are then securely tacked and a series of small holes punched along the inner edge of each of the folds. The flies, in trying to go in and out through the window, crawl into the folds and enter the holes at the apex, but never escape, as on the inside the holes are along the projecting ridge. Prof. Hodge states that a trap set in a window in a basement barn near a cow within caught nearly 5 quarts of flies from July 1 to November 1. The stable fly constituted 90 per cent of these flies.

FIG. 7.—The Hodge flytrap, showing where the flies enter. (Hodge.)

This trap is inexpensive and can be made by anyone with a box, or box lumber, and screen wire. It is especially well adapted to well-made barns where the flies do not have numerous places for entrance and exit. It is also more applicable to small barns in which animals are kept more or less constantly than to large dairy barns where the cows are brought in only at milking time. Under the latter conditions the flies enter the barns on the cows and many remain on the walls of the barn until after the cattle have been turned out. In some cases where flies are concentrated in dairy barns in this manner they have been driven out by forcing live steam into the building from the boilers used for sterilizing purposes. Where such arrangements are made the flies may be caught in such traps as the one described, as they are endeavoring to escape from the barn, which should first be tightly closed.

FIG. 8.—The Hodge flytrap fitted to a barn window. (Hodge.)

If such barns are tightly closed, as above, during the light part of each day and the windows without traps darkened, practically all the flies will "catch themselves" in trying to escape through the trap-window or windows.

DESTRUCTION OF IMMATURE STAGES AND PREVENTION OF BREEDING.

Since straw stacks have been found to be the principal breeding places of this insect in the grain belt, the proper care of the straw is by far the most important step in control. When the straw is to be kept for protection and food for live stock, it should be stacked with more than ordinary care. The sides of the stack should be made nearly vertical and it should be rounded up well on top, the better to

shed the rain. With blower stackers a very satisfactory stack can be put up by controlling the blower and keeping one or two men on the stack. This method is shown in figure 10. After the stack is complete it is advisable to clean up around its base and to scatter or burn the loose straw and chaff.

So far as possible, all straw which is not required for winter feed for stock should be disposed of immediately by scattering it over the land soon after thrashing and subsequently plowing it under, or by burning the stacks. The plowing under of the straw which can not be used for feed is the most advisable procedure, in regions where the moisture is sufficient to cause it to rot rapidly. Oat straw is most generally used for feeding purposes, and this straw forms the principal breeding ground for flies. It is therefore important in regions where rainfall is heavy that all oat straw needed for feed or bedding be baled and stored under cover and that the remainder be promptly

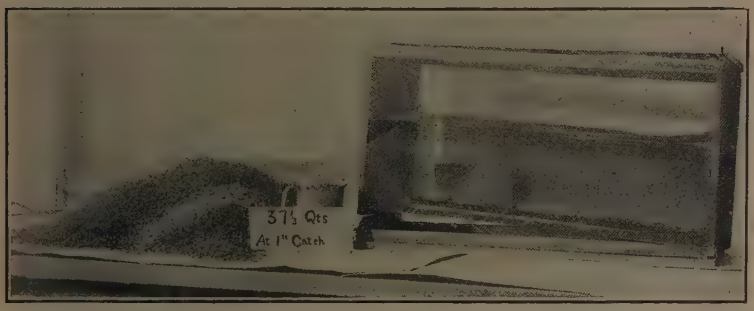

FIG. 9.—Pile of flies caught in a Hodge flytrap. (Hodge.)

burned or scattered. In the dryer sections of the country proper stacking of the straw may be depended upon for its preservation.

All straw stacks not consumed by stock during the winter should be promptly disposed of in the early spring, as these stacks furnish flies continuously during spring and summer. Often the flies reared in such situations are abundant enough to cause great annoyance to live stock during early spring, and by multiplying throughout the summer an almost incredible number are produced by fall.

The conditions—that is, the heavy rainfall on the freshly thrashed straw—which have produced most of the severe outbreaks render the straw largely unfit for feed for live stock, as the stacks in many cases are wet through and soon become heated and rotten. In such instances, where the flies are already breeding in these stacks, their immediate destruction by burning or scattering is necessary to

relieve the conditions. When stacks are scattered the work should be done thoroughly, so as to expose the straw completely to the influence of the sun, wind, and light. By this procedure practically all of the larvæ and many of the pupæ are destroyed. Straw spreaders are on the market which are said to give satisfaction.

It is best to plow under the scattered straw soon after it has become well dried out. In many sections of the grain belt plowing is not generally practiced, the land being simply disked prior to seeding. The scattering of straw over the ground in such cases is less practicable than where the land is plowed; hence wherever plowing can be done it should be adopted.

FIG. 10.—Stacking straw to prevent stable fly breeding.

In sections of the country where headers instead of binders are used, and consequently a smaller amount of straw is accumulated, the straw is much more easily disposed of by the methods just outlined.

The use of poisons or other substances, with a view of destroying immature flies in the substances in which they are breeding, is neither practicable nor advisable. Enormous quantities of these materials would be required to permeate the straw or manure piles to kill the flies, and, even though the flies were destroyed, the straw would be rendered dangerous to live stock.

Although straw is the principal breeding place for stable flies within the grain belt, there is no doubt that thousands of them develop in manure piles. Moreover, such material is utilized exten-

sively as a breeding place for the house fly and horn fly. Hence the proper care of all sorts of animal refuse is essential for successfully combating the pest. Manure should be hauled out and scattered at regular intervals, preferably every three days, as is recommended for the control of the house fly, and any accumulations of straw or hay, especially adjacent to stables, should be disposed of, as these are often utilized for the breeding of the stable fly when larger accumulations of horse manure and straw are not available.

Manure boxes provided with a trap on top to catch the flies which breed out (fig. 11) prove very satisfactory for farms with a few

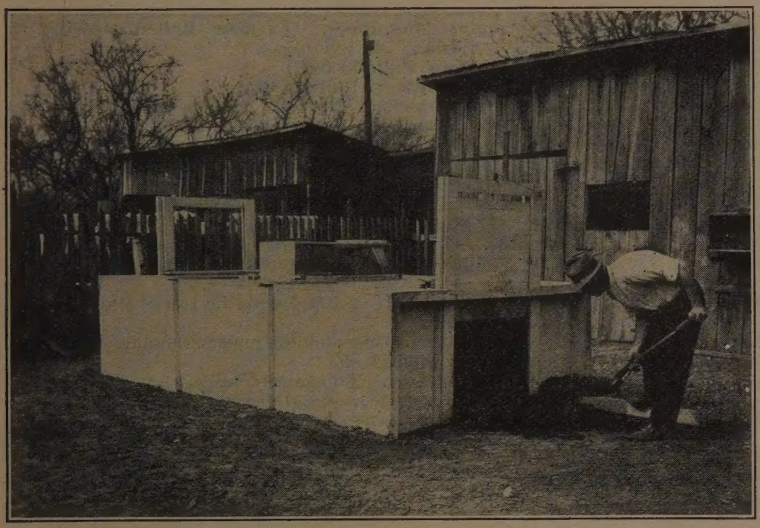

FIG. 11.—Manure box with flytrap attached.

head of stock. The box should be as nearly fly-proof as possible and the manure put into it at least every four days so as to catch the house flies as well as stable flies.

Manure pits properly screened and with flytraps provided are adaptable to use on dairy farms, and the maggot trap described in Farmers' Bulletin 851 will destroy many stable fly maggots as well as those of the house fly.

The need of properly caring for stable refuse is still further emphasized by the fact that there are far more manure piles than straw stacks. Furthermore, the stable manure is usually in close proximity to the habitations of man and thus furnishes flies which have freer access to man, with consequent greater potentiality as disseminators of human diseases.

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